

Support to aquaculture and fishery making use of Copernicus Marine Service

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**COPERNICUS program :**

- Sustainability of marine products procurement from Earth Observation, modelling and in situ
- Reliable service of distribution and Quality Control

SAFI EU project (Sustain our Aquaculture and Fishery Industry)

- Many scientific progresses based on previous EO missions but limited in demonstration
- Main observation methodologies applied to aquaculture and fishery have been tested and, when successful were implemented (and documented) in an operational processing chain

-> Start of a real operational service

Today : focus on support to aquaculture



CMEMS relevant for aquaculture

Water Quality characterisation :

- ✓ Sea water coloration (marine optics) (Sat)
- ✓ Chlorophyll-a surface concentration (Sat)
- ✓ Turbidity (Sat)
- ✓ Sea surface temperature (SST) (Sat/model)
- ✓ Dissolved oxygen (O₂) (model)
- ✓ PH (model)

Sea state characterisation

- ✓ Waves (model)
- ✓ Currents (model)
- ✓ Winds (model)



SAFI added-value by using CMEMS

Water Quality characterisation :

- ✓ Eutrophication risks
- ✓ Harmful Algal blooms risks
- ✓ Pollution risks (oil, waste, ...)
- ✓ Water transparency

Optimisation of sites for farming

- ✓ Bathymetry estimates
- ✓ Shallow water benthic classification
- ✓ Best location for farming (Env. conditions for species growth)
- ✓ Best location for farming (Physical conditions for farming equip)
- ✓ Productivity estimates (for bivalves)
- ✓ Statistics / risk occurrences

Near Real Time monitoring for any sites

- ✓ All parameters in NRT from CMEMS & SAFI

Some HABs have well specific optical properties

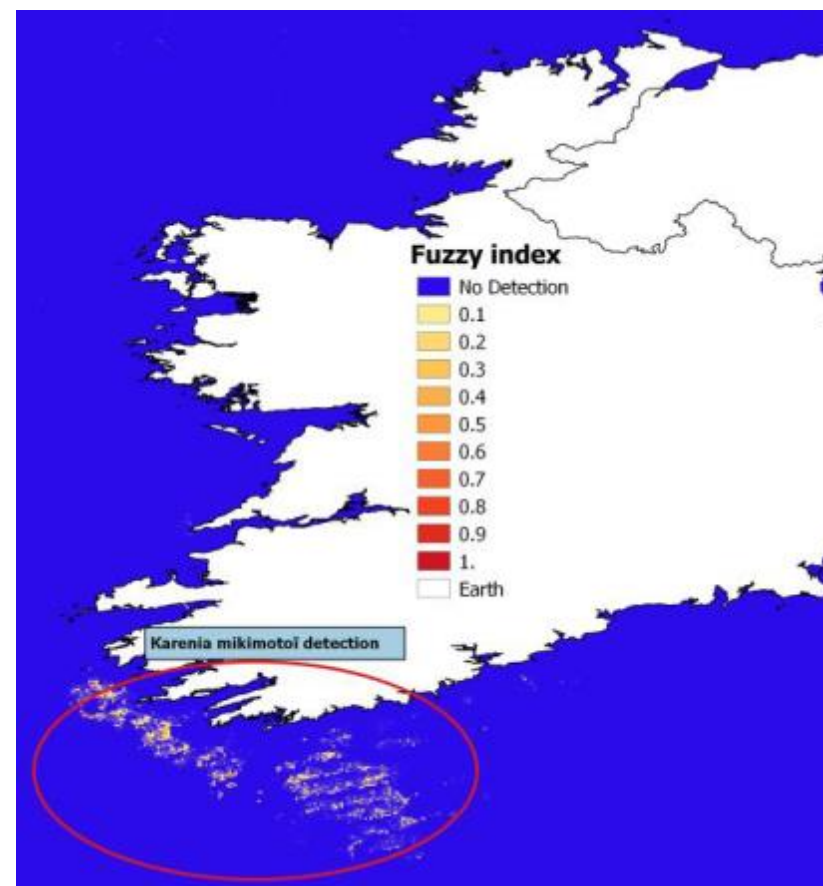


Lepidodinium chlorophorum in Loire plume (France)

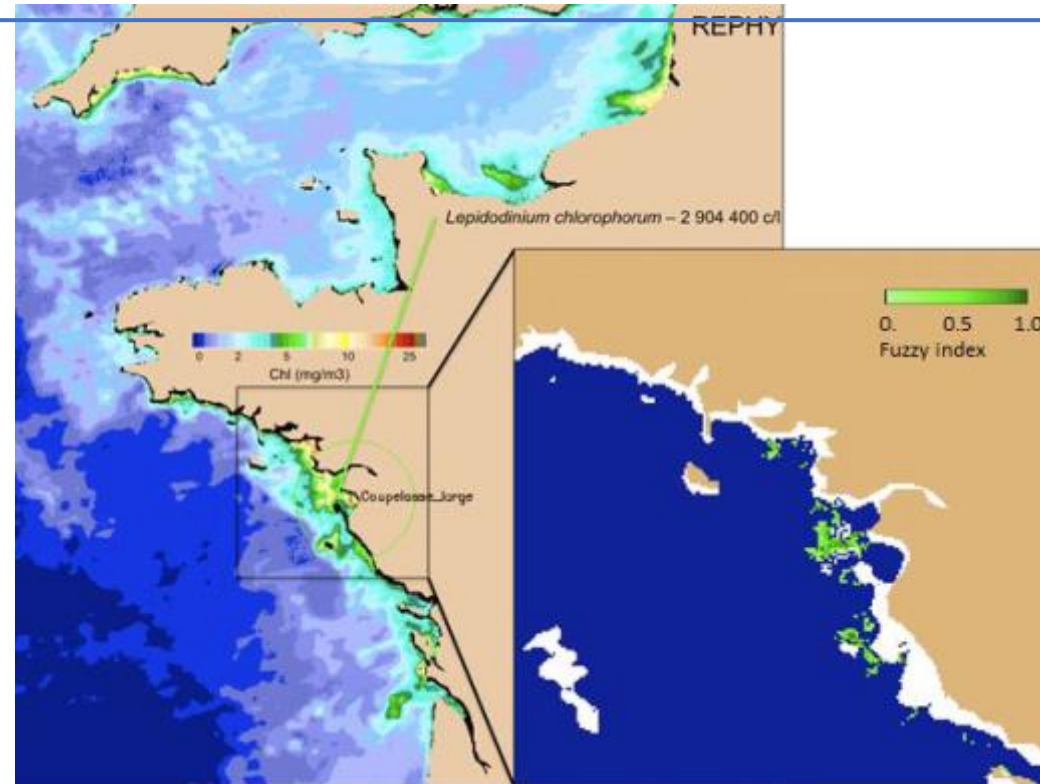


Noctiluca scintillans in French Brittany

- *Karenia mikimotoi* – **red tide** blooming – potentially toxic
- **Application:** To detect a possible toxic algal bloom and anticipate its drift into sensitive areas such as fish and shellfish farms.
- **Availability:** Daily at 1km resolution
- **Limitation:** Detection only possible for high biomass blooms.
- The actual toxicity of a potentially toxic species needs to be confirmed with ground sampling.



- *Lepidodinium chlorophorum* = *green tide*
- Not toxic
- **Application:** to anticipate bloom drift into sensitive areas such as fish and shellfish farms.
- **Availability:** Daily at 1km resolution
- **Limitation:** Detection only possible for high biomass blooms.

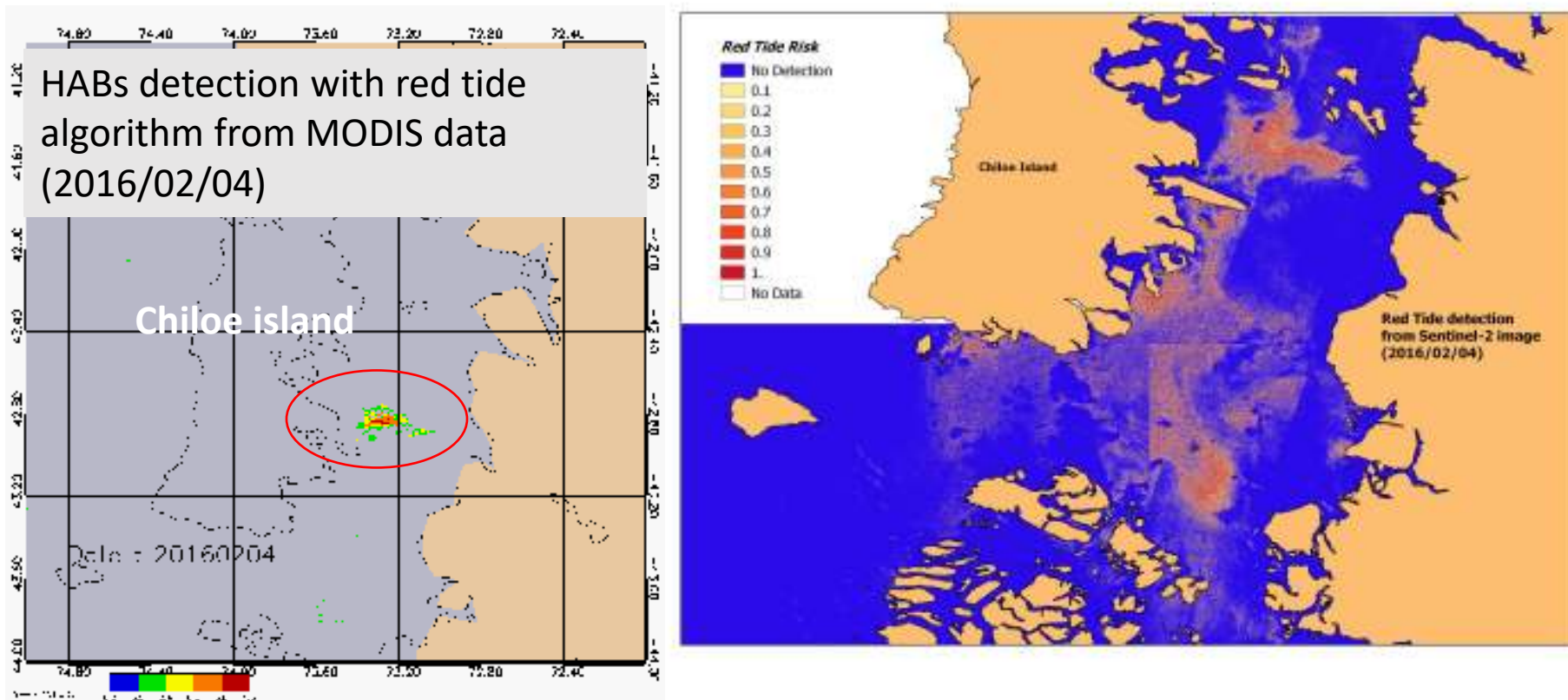


L. chlorophorum BLOOM DETECTED BY SAFI (28/03/2013) IN THE LOIRE PLUME FRANCE (right) AND CHLOROPHYLL-A CONCENTRATION (left) ESTIMATED FROM SPACE

Used of High Resolution Earth Observation sensor :

Red tide detection algorithm adapted to Sentinel-2 high resolution imagery from ESA (10x10m) for Chiloe HAB:

Sentinel-2 pixels co-localised with the red tide pattern detected with MODIS (6 bands) were used to setup spectra of reference with the available 3 bands of Sentinel-2. Red tide detection algorithm was applied to the 3 Sentinel-2 images at the same date.



- **Based on** Sea surface temperature, chlorophyll-a concentration and significant wave heights information
- **Application:** to identify or confirm areas suitable for mussel farming.
- for selection of optimal farming
- areas and licencing applications.
- **Availability:** Maps available at 1km resolution, updated yearly.
- **Limitations:** Earth Observation present limits of detectability (and so reliability) on shallow waters areas, that prevents some close-to-the-coast identifications (where some mussels farms are located).



Parameters used:

Chlorophyll-a GSM_CHL1

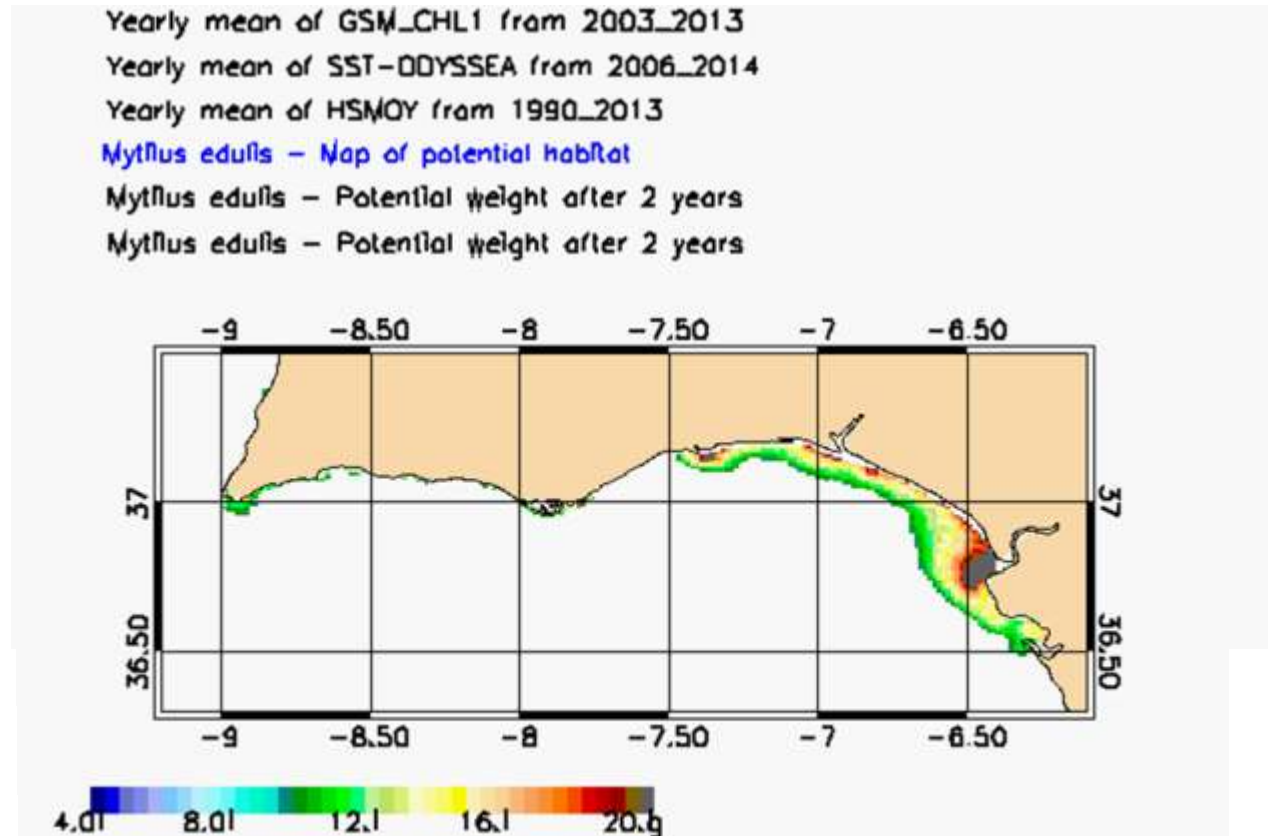
SST-ODYSSEA

Waves CERSAT

- Potential Habitat
- Potential weight (g)

Algorithm :

Y. Thomas et al. 2011

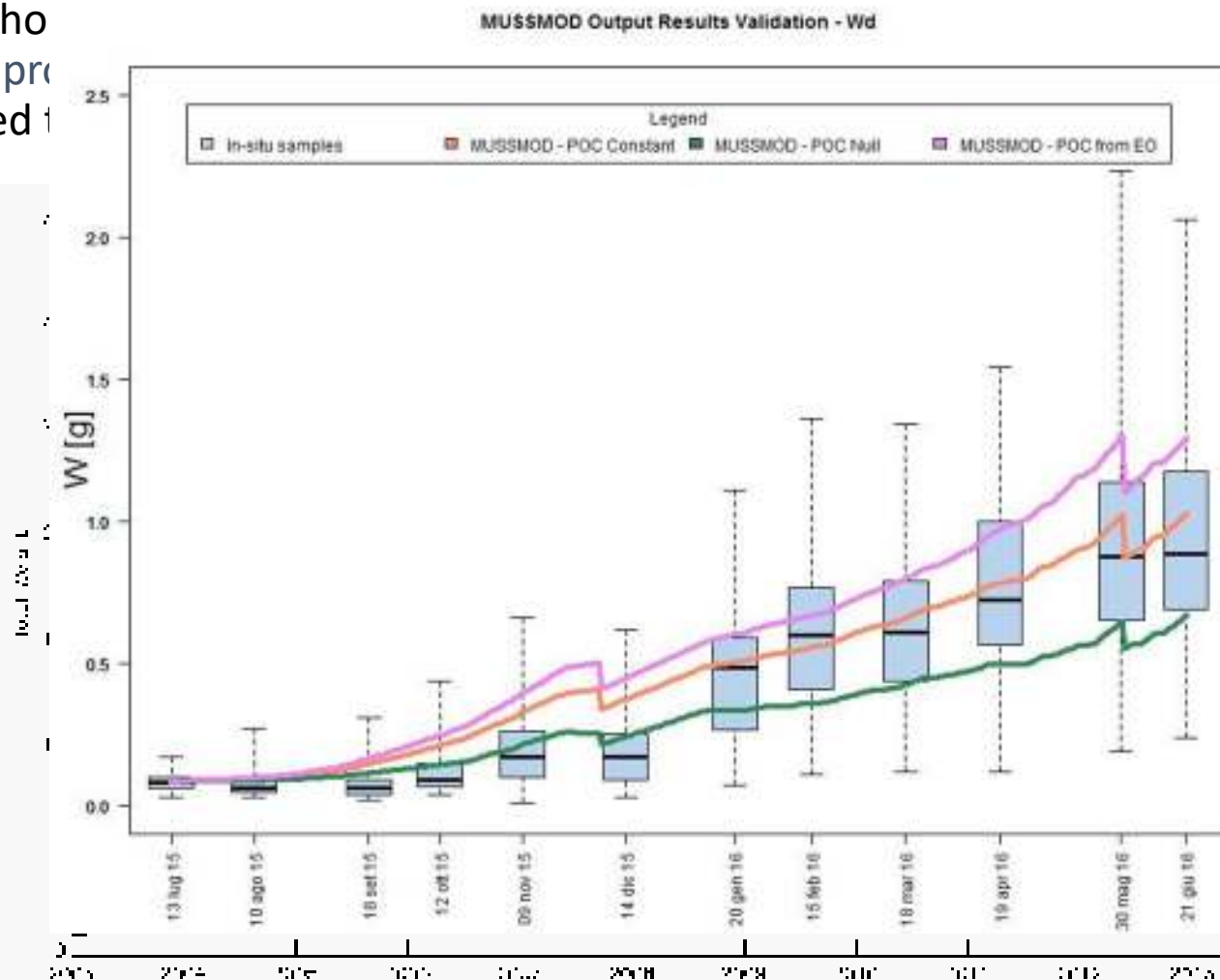


- Indicator setup for potential mussel (*Mytilus edulis*) growth in French Brittany easily adaptable to other species with *in situ* data.

Limitations : Impact of specific events like production loss due to diseases or harmful algal bloom occurrence cannot be considered in this yearly growth estimation.

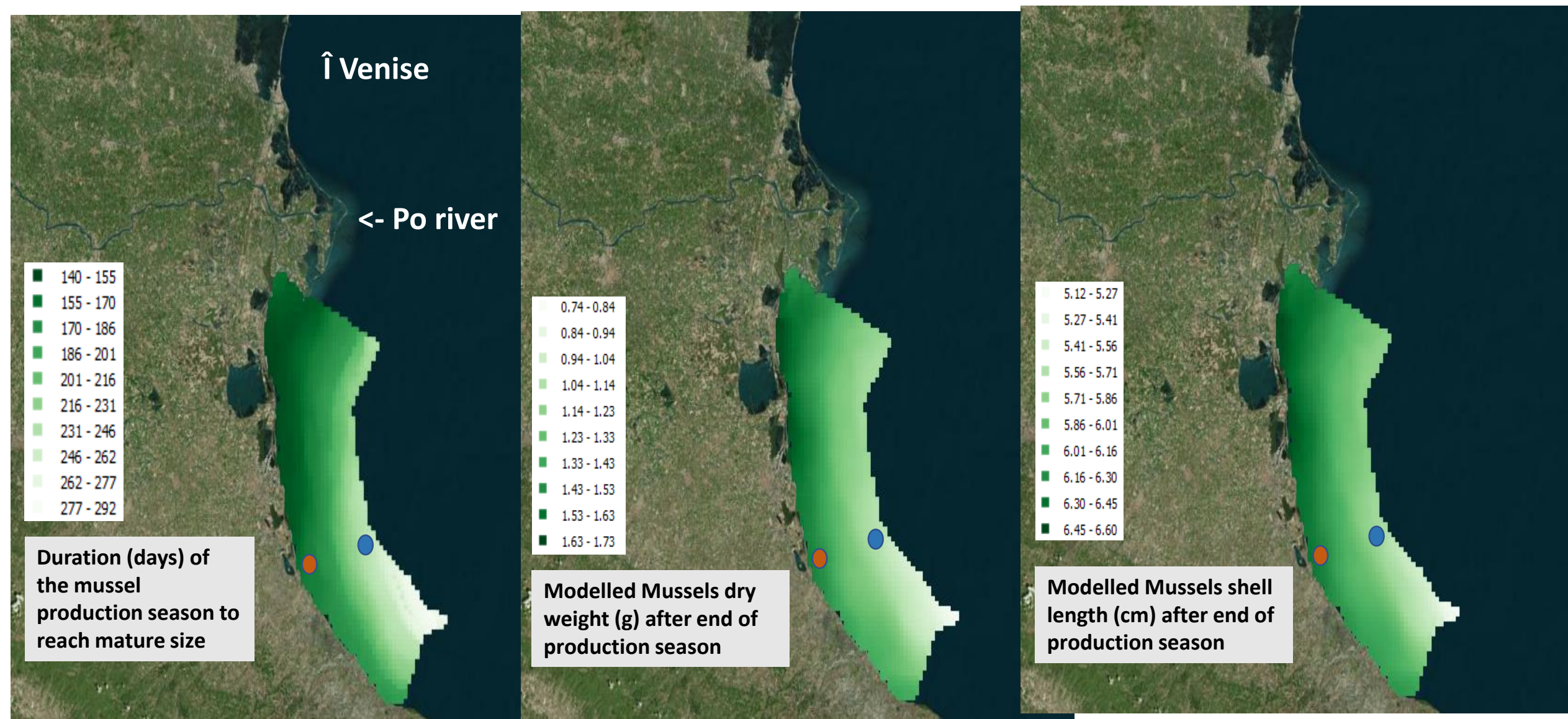
Use of the indicator for another species

- The method (SMART procedure) compared



Adriatic Sea
were

(L1)
nated)



Salmon Farming

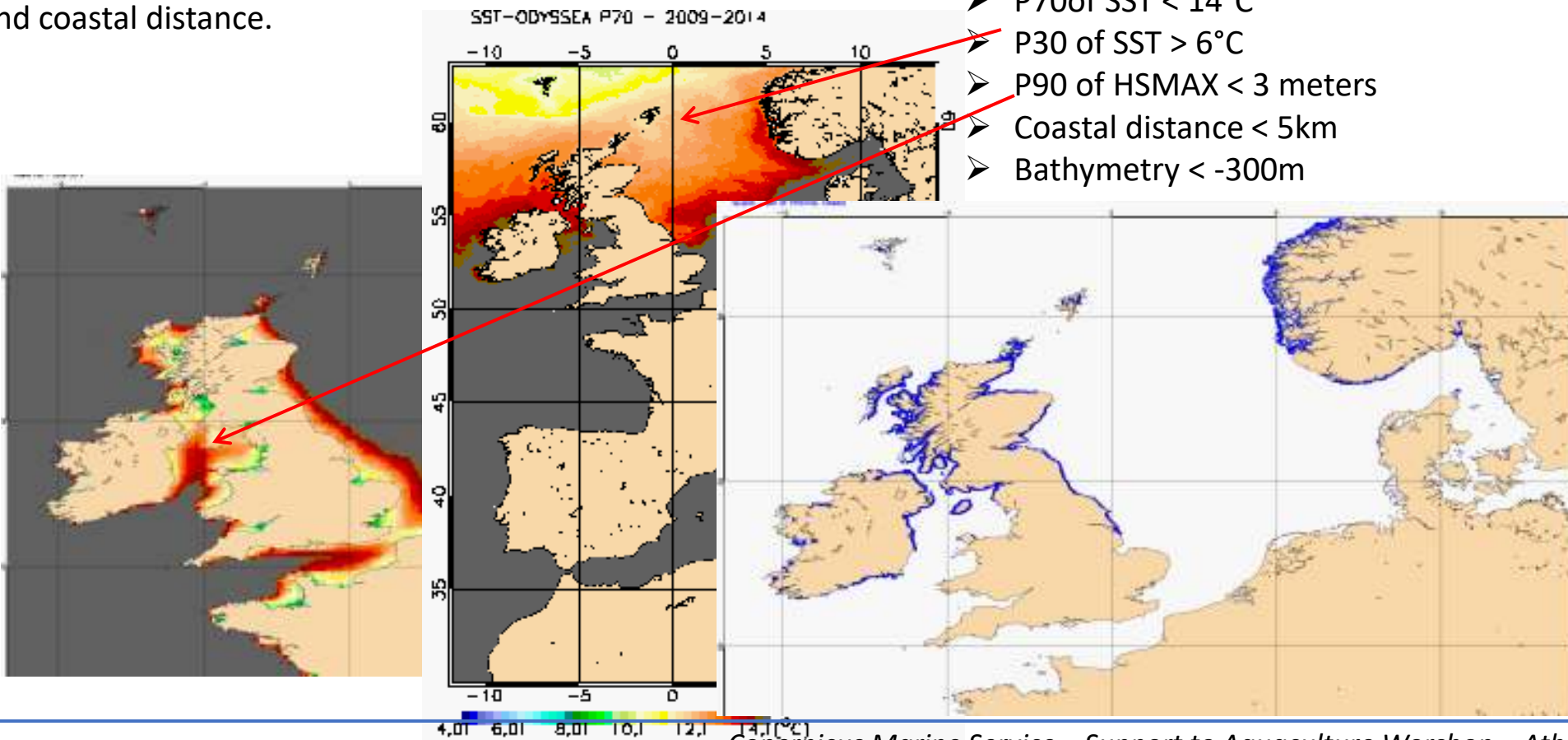
Object: use environmental Earth Observation (EO) data to evaluate the potential areas for salmon farming

Dataset: Daily data computed on the “Europe” area.

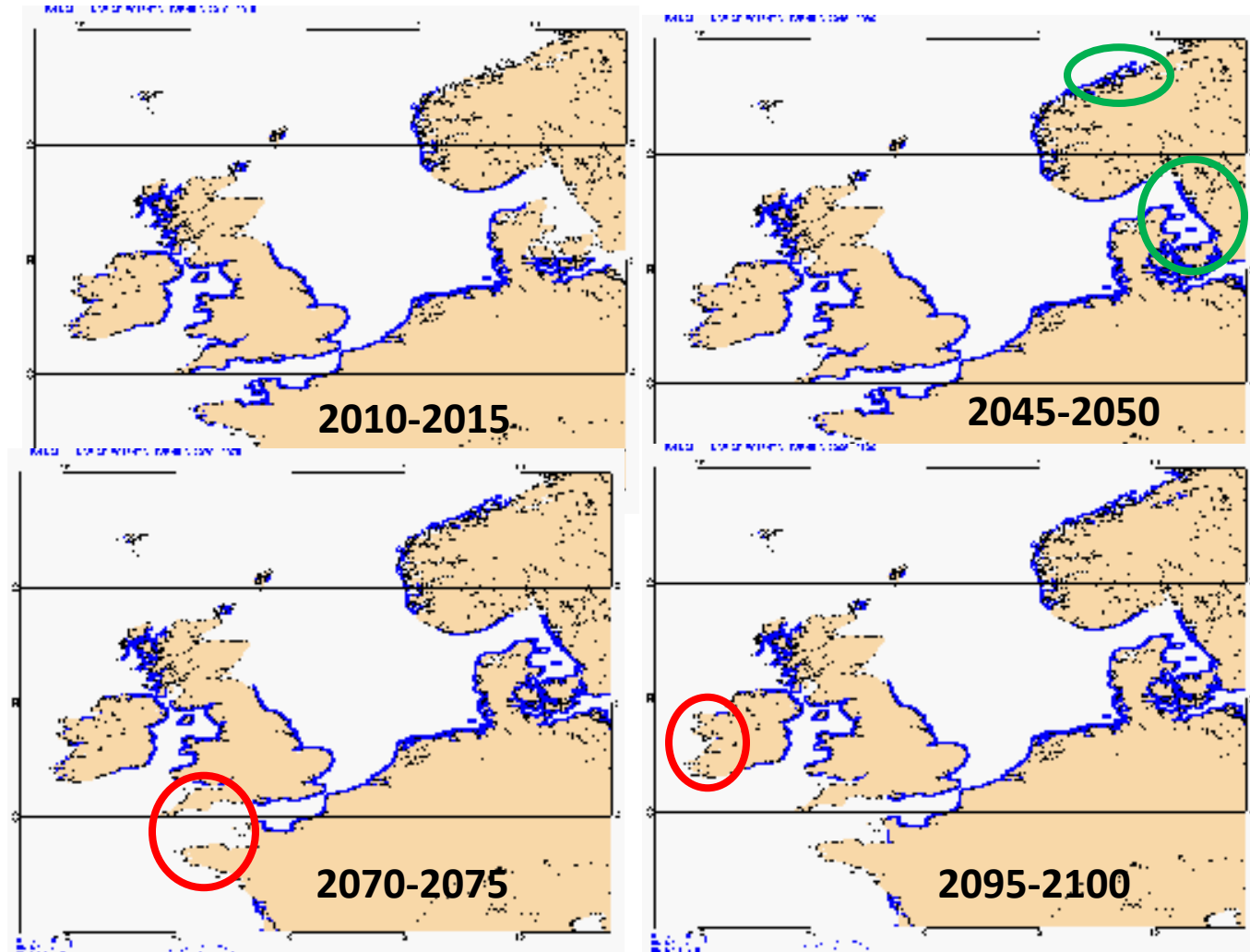
- Sea surface temperature (SST) ODYSSEA
- Maximum Hs of the day (HSMAX) WW3 model
- Bathymetry and coastal distance.

Methodology:

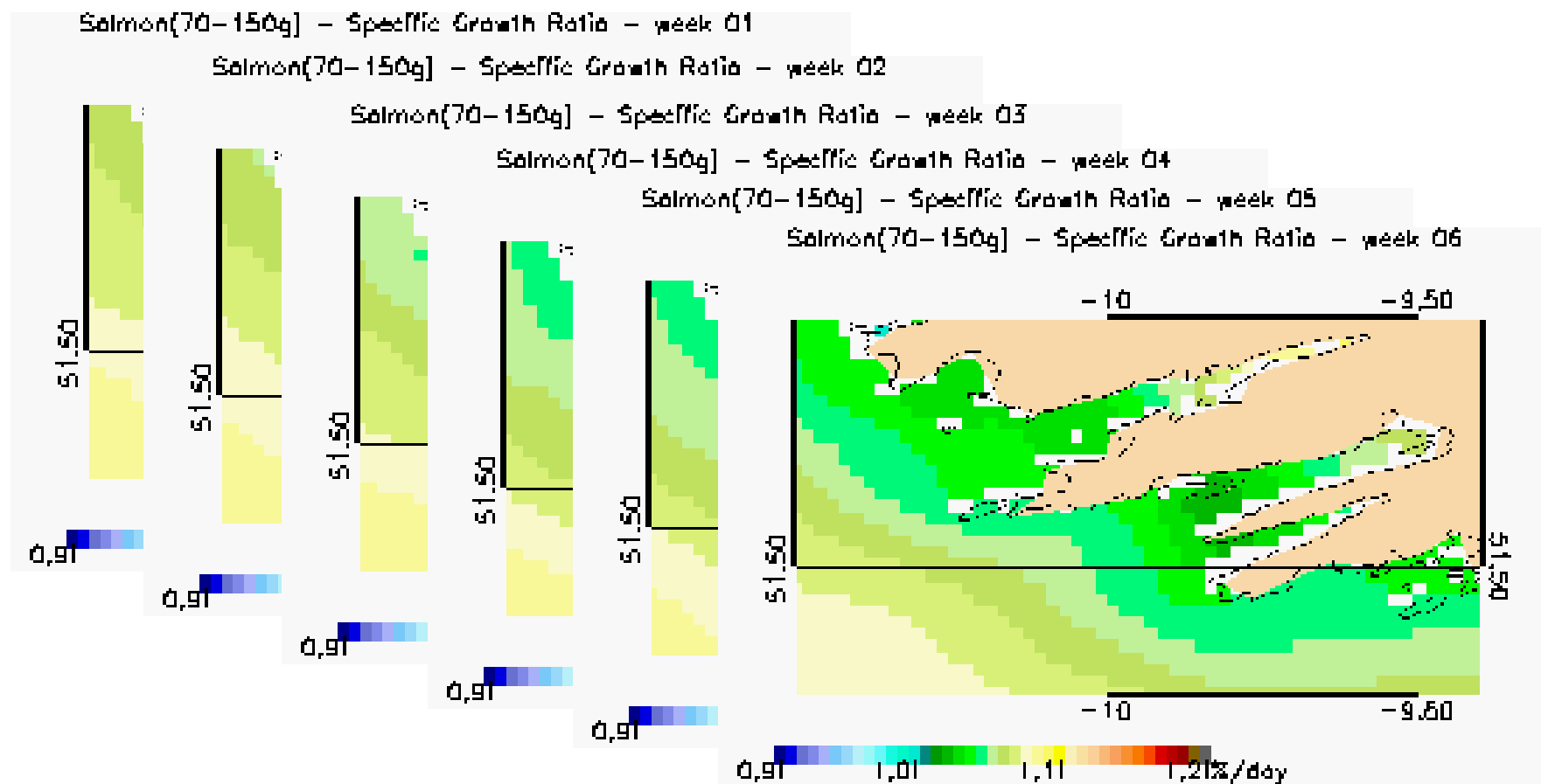
- The 10th, 30th and 70th and 90th percentile (Pxx) has been computed from daily images over a period of six years (2009-2014)
- Then data crossing has been adjusted to exclude the areas which don't agree with these criteria :
 - P70 of SST < 14°C
 - P30 of SST > 6°C
 - P90 of HSMAX < 3 meters
 - Coastal distance < 5km
 - Bathymetry < -300m



Evolution with climate
(*IPCC medium scenario*)



- Growth factor for juvenile salmon based on SST.
- The effect of temperature and fish size on **growth** (Handeland et al.)

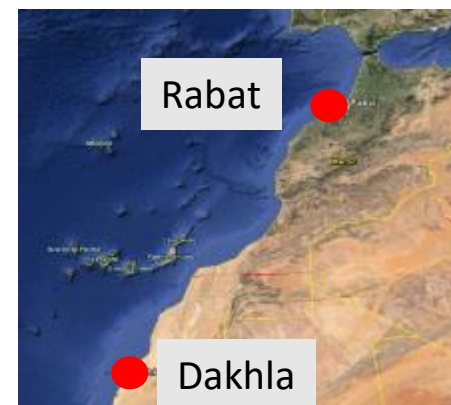
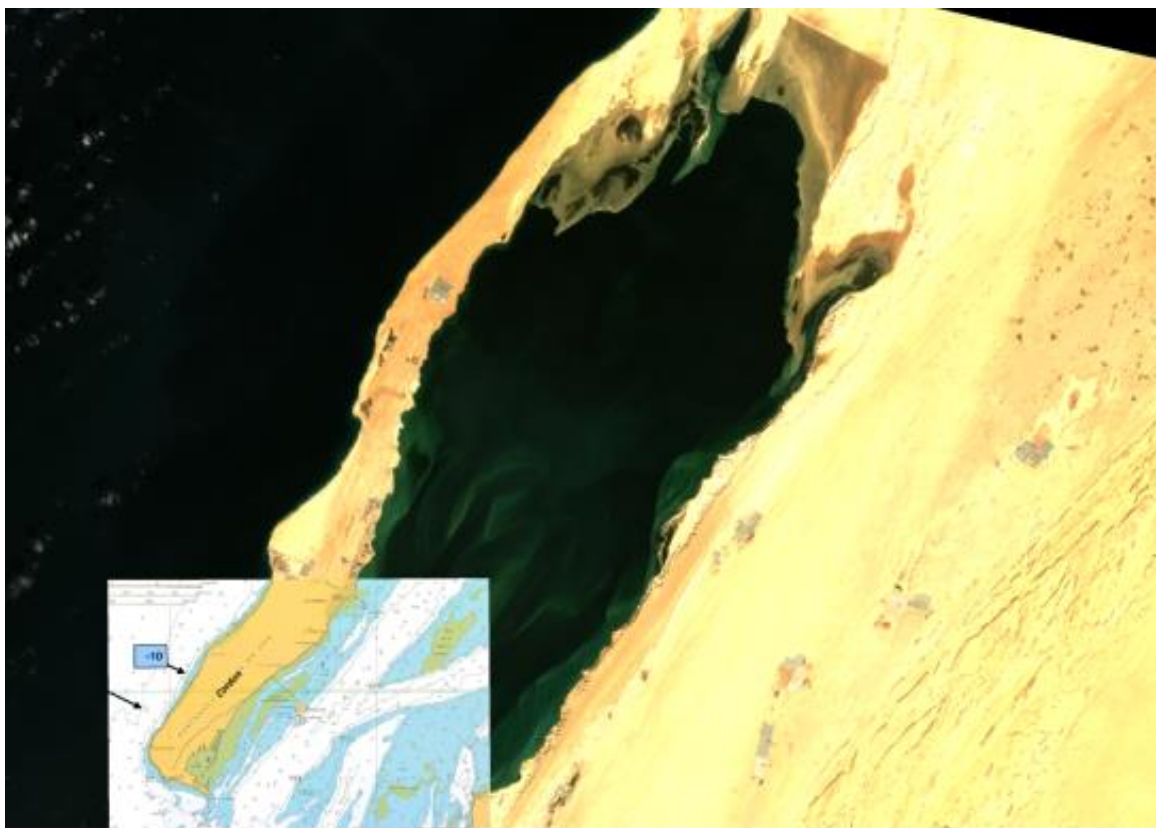


Transparency
(SECCHI>4m)

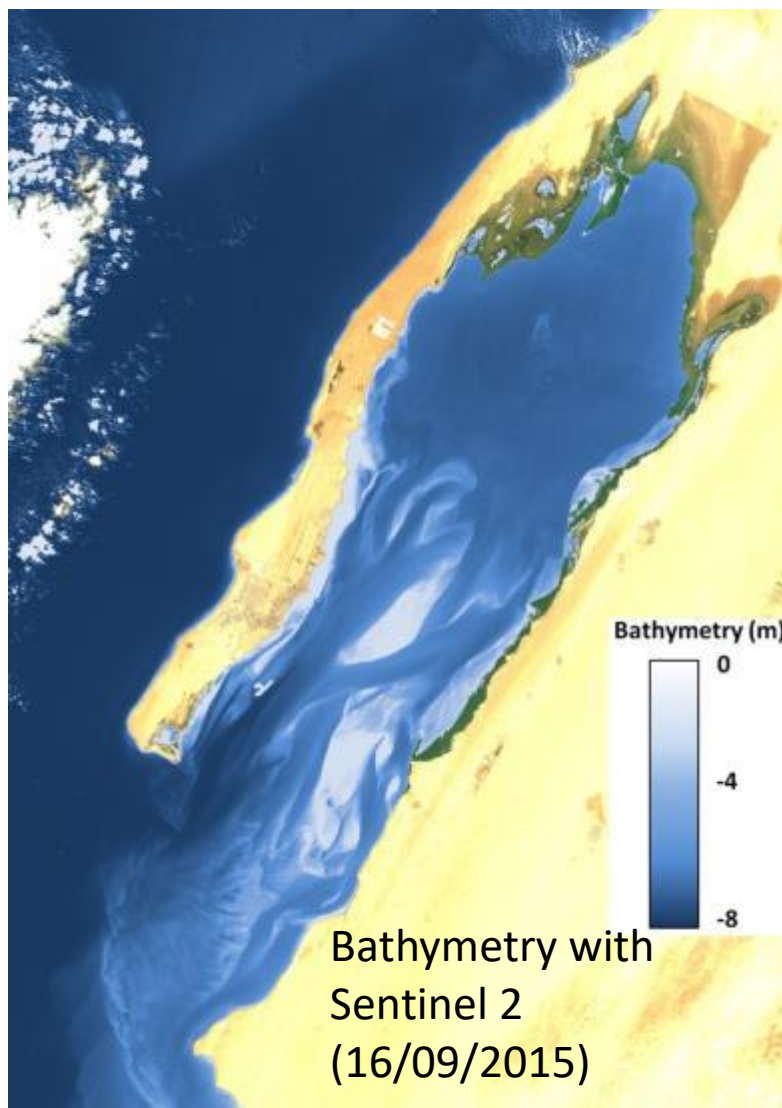


Dakhla bay, South of Morocco:

studies on aquaculture development – test facilities (INRH, AQUALOG)



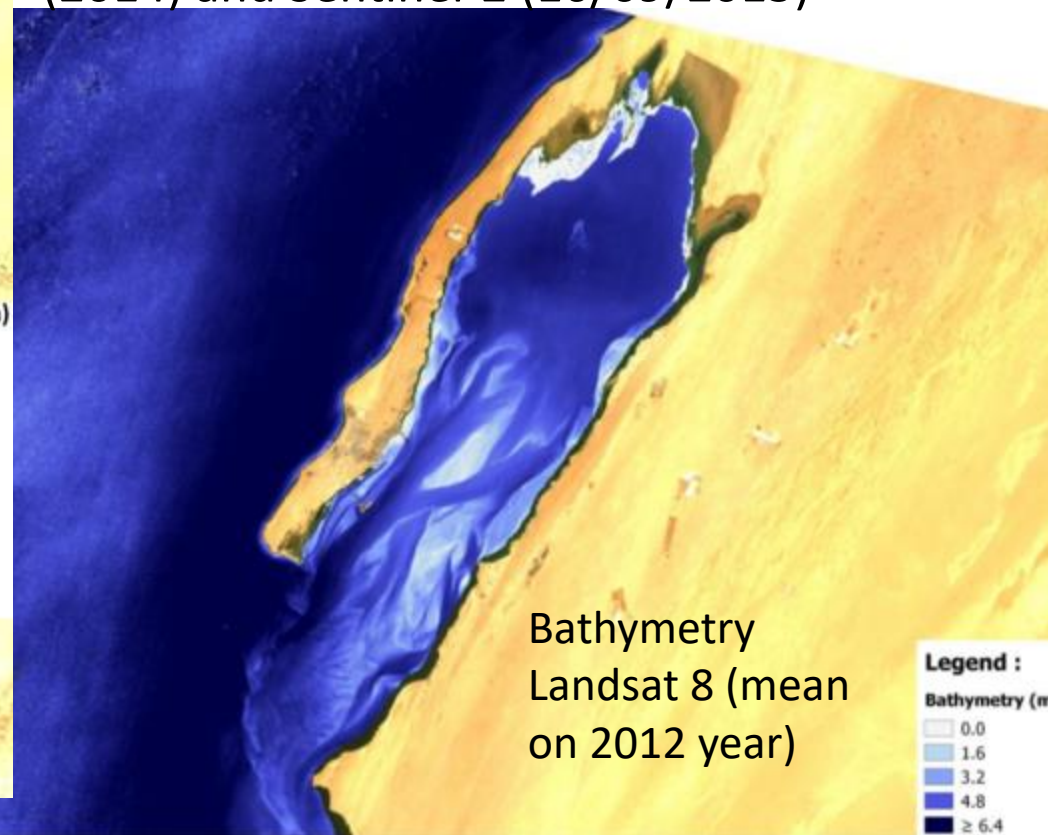
Very dynamic area in terms of sedimentary processes (dredging strategy required)
Available bathymetry dating back 2003 (SHOM) -> Update needed



S2A_OPER_PRD_MSIL1C_PDMC_20150916T153858_R080_V20150916T114837_20150916T114837

Depending on the tidal time, water is clear enough to allow bathymetry retrieval down to 6 to 8m depth.

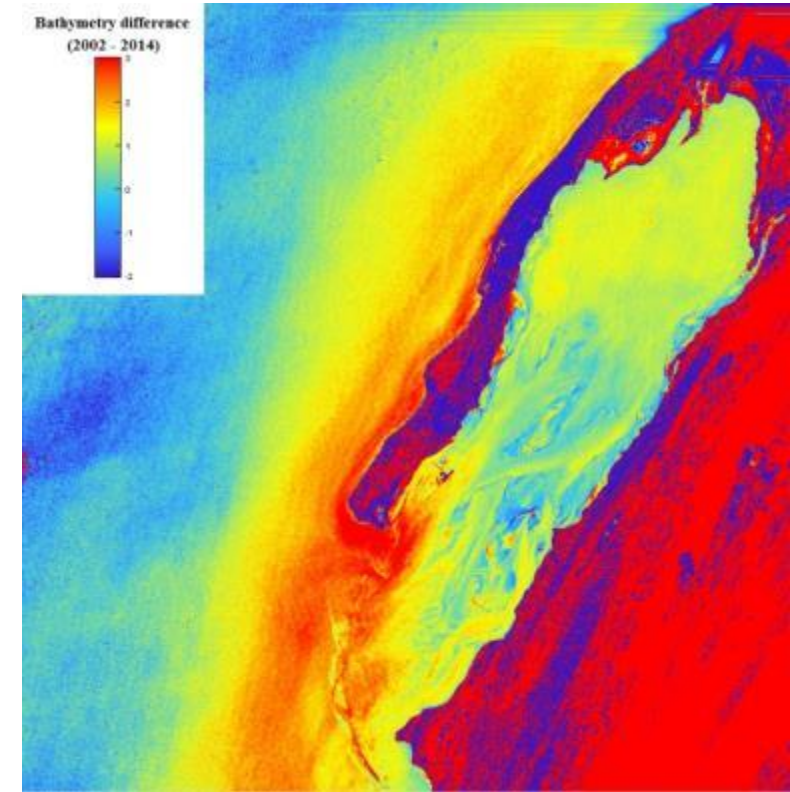
Satellites used: Landsat 7 (2002), Landsat 8 (2014) and Sentinel-2 (16/09/2015)



Application:

- For areas with **little monitoring**, where measurements are difficult to make (e.g. **too shallow**) or not recently updated.
- to **estimate the sedimentary processes** comparing two estimated bathymetries

Here difference between 2002 and 2014 (landsat):
(red=increase in sediments – lower depth
light blue= no change
dark blue= decrease in sediments – higher depth)



Availability : Processing is not automated – specific studies required to adapt the algorithm to the area of interest.

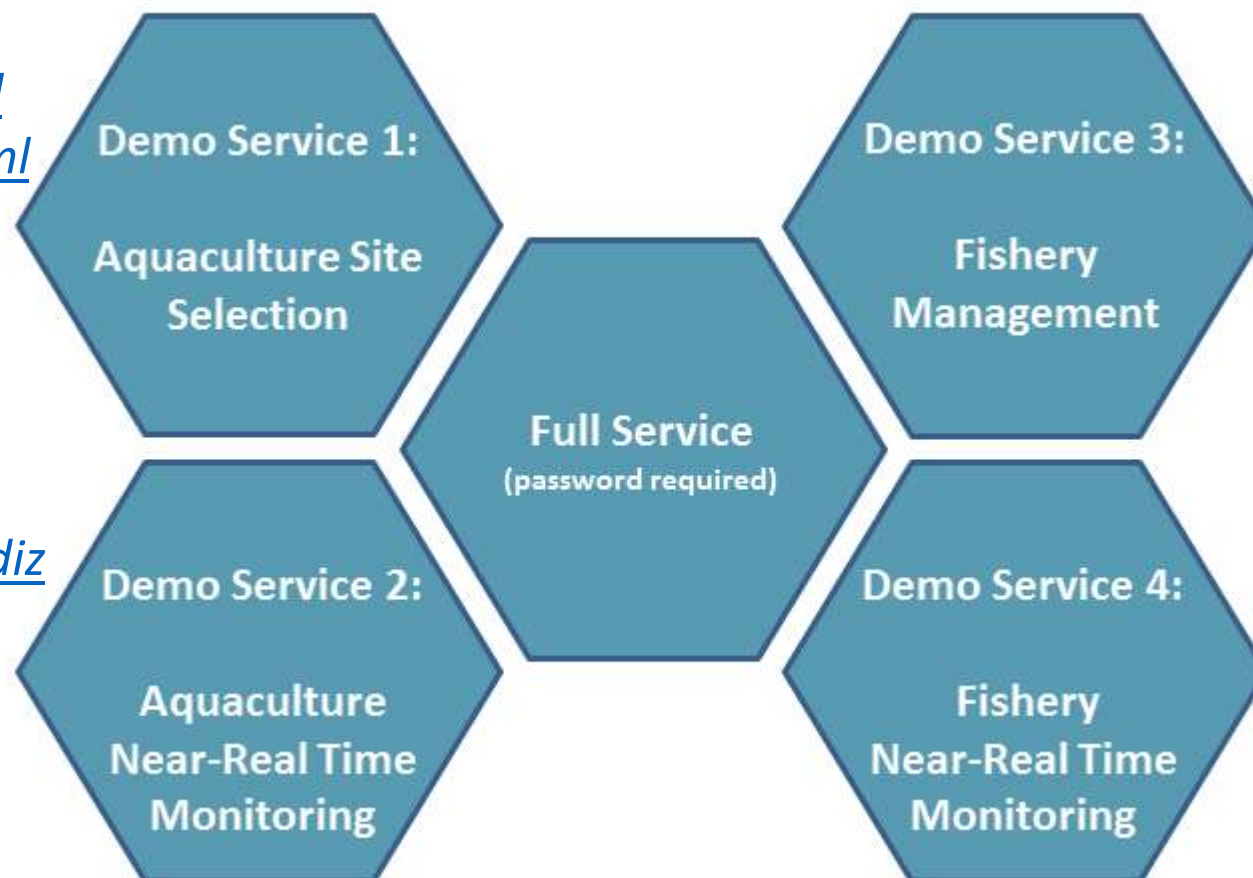
Limitations : only valid for **shallow waters** (limit depth depending on water transparency)
– as we need to see the bottom from space.
Optic remote sensing is **not exploitable in cloudy conditions**.

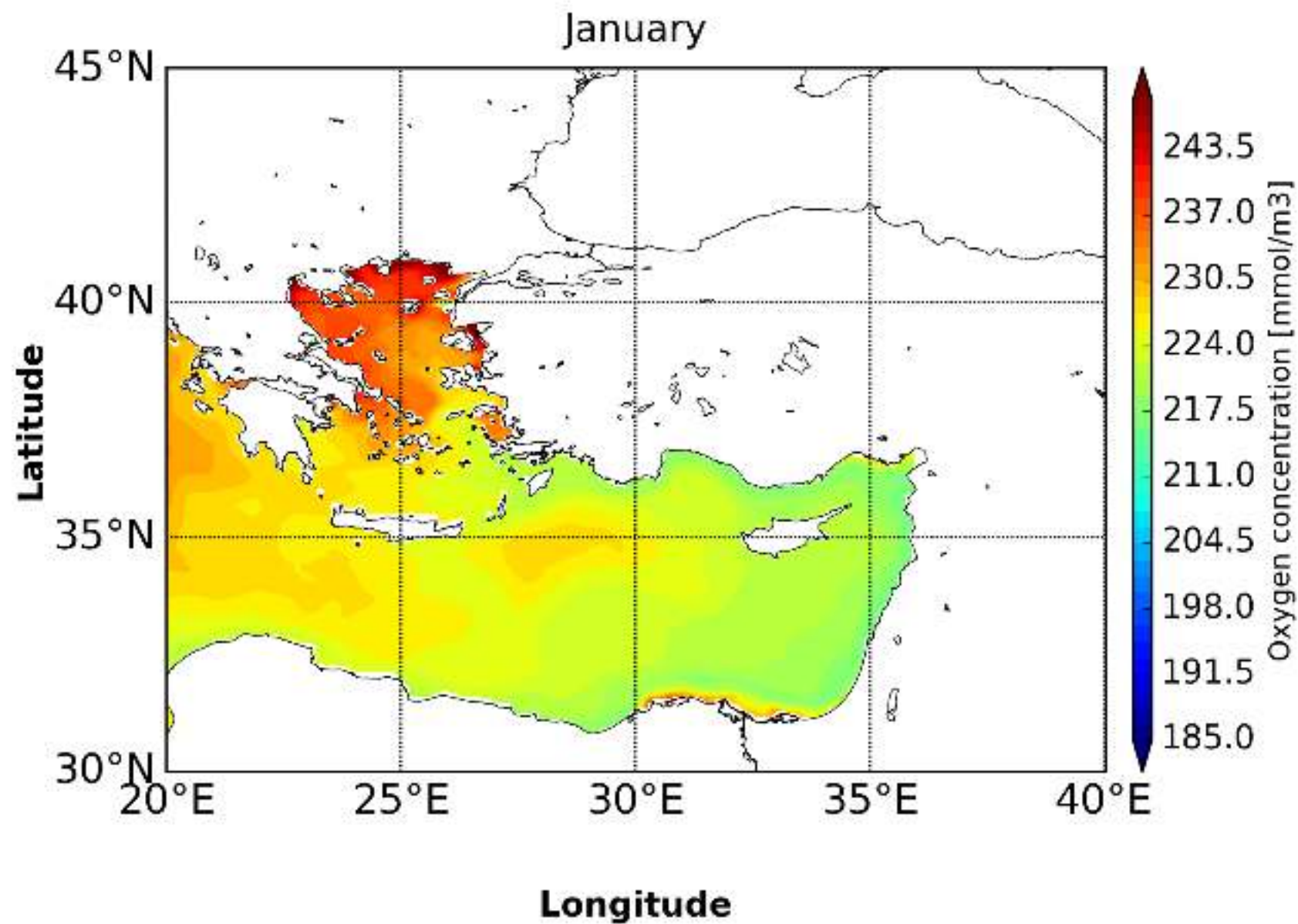
V1: <http://safiservices.ucc.ie/index.html>

V2: <http://safiservices.ucc.ie/index2.html>

<http://www.acri-he.fr/projects/safi/cadiz>

Demonstration/training
tomorrow (25 sept. 14:00)





Such service today's exists because of Copernicus Marine service offer
(but not only – CMEMS is acting as a data provider but also as backbone/federator)

Extension of EU SAFI and other existing services through:

- Increased dialogues with users (workshop's objectives)
- Enlarged data access : e.g. **EU IMPAQT** project including
 - IOT
 - Copernicus & SAFI services for aquaculture
 - Crowdsourcing

See me and/or Frank Kane (MI) and/or Panagiotis Vlachas (WINGS)
- Refined approach close to the farm: e.g. **EU HISEA** project for refined [modelling](#) and combination of data)

See me and/or Ghada El Serafy (Deltares)

Thank you for your attention !

**Support to aquaculture and fishery making use of
Copernicus Marine Service**

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Improving Operation, Planning,
and Management of the Marine Sector

HISEA INTRODUCTION

Copernicus Marine Services for the Aquaculture Sector

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Deltares

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Overview

Period	30 months starting January 2019
Sectors	Ports & Aquaculture
Resources	~2.4 Million (~1.9 Million EU grant)
Program	DT-SPACE-01-EO-2018-2020 Copernicus Market Uptake
Products	High resolution added value products that will be a clear extension of three different core services dealing with the coastal areas: Copernicus Marine Environment Monitoring Service (CMEMS) and Copernicus Land Monitoring Service (CLMS) and the Climate Change Monitoring Service (CMS).
Components	Models, DIAS, Copernicus data , Data science, Visualization and apps, Crowdsourcing , EO
Impact	Attending user needs, accuracy, reliability , affordability, sustainable downstream service
Partners	

Objectives

Deliver accurate and reliable information, readily available, easily understandable and with high resolution

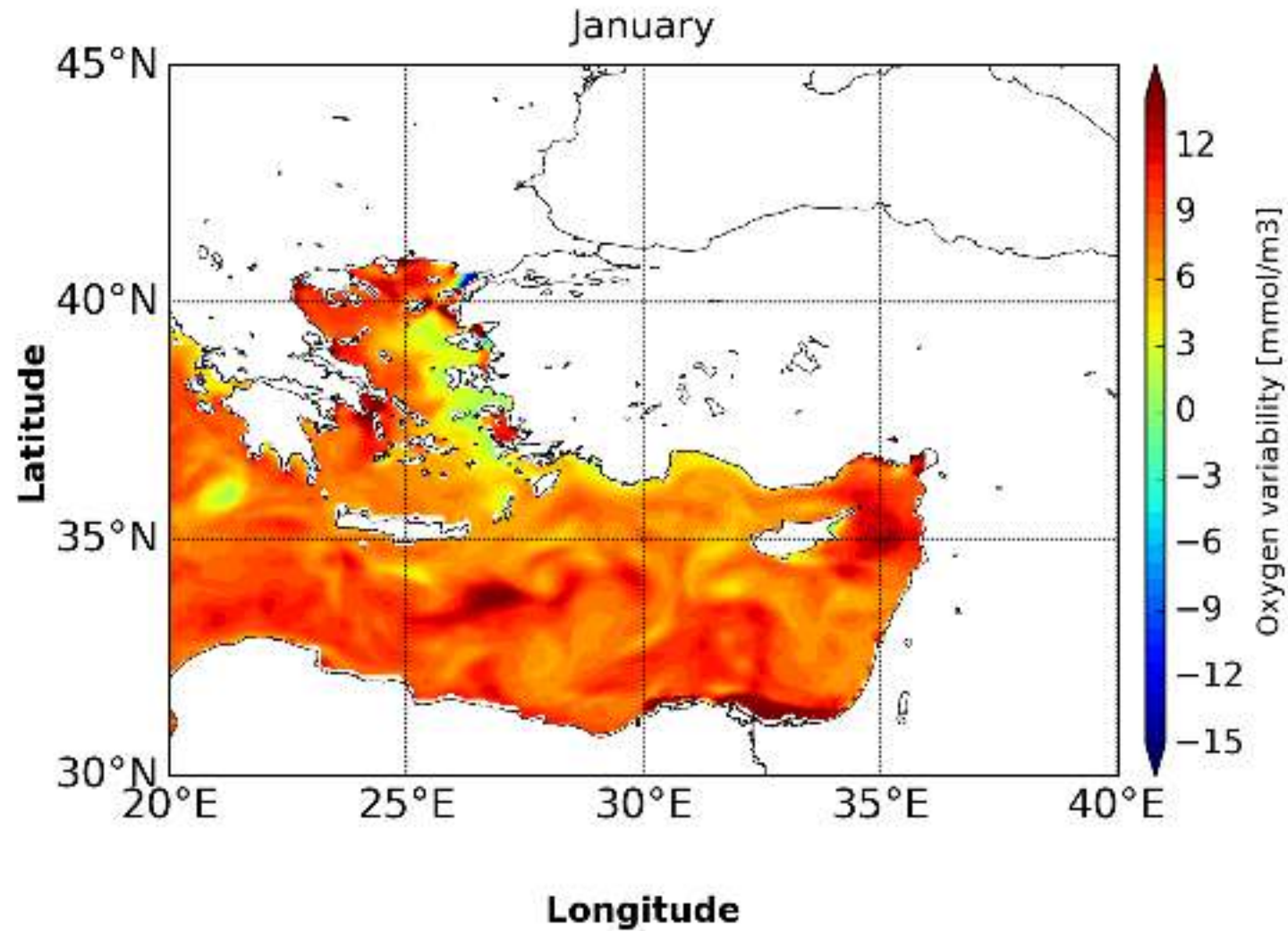
HiSea solution

- ✓ **Co-designed** with users
- ✓ Provides **high resolution** data of **water quality** at sea
- ✓ Targets **port** and the **aquaculture** sectors
- ✓ Develops operational **Copernicus-based downstream information services**
- ✓ **Improves operation, planning and management** of marine activities

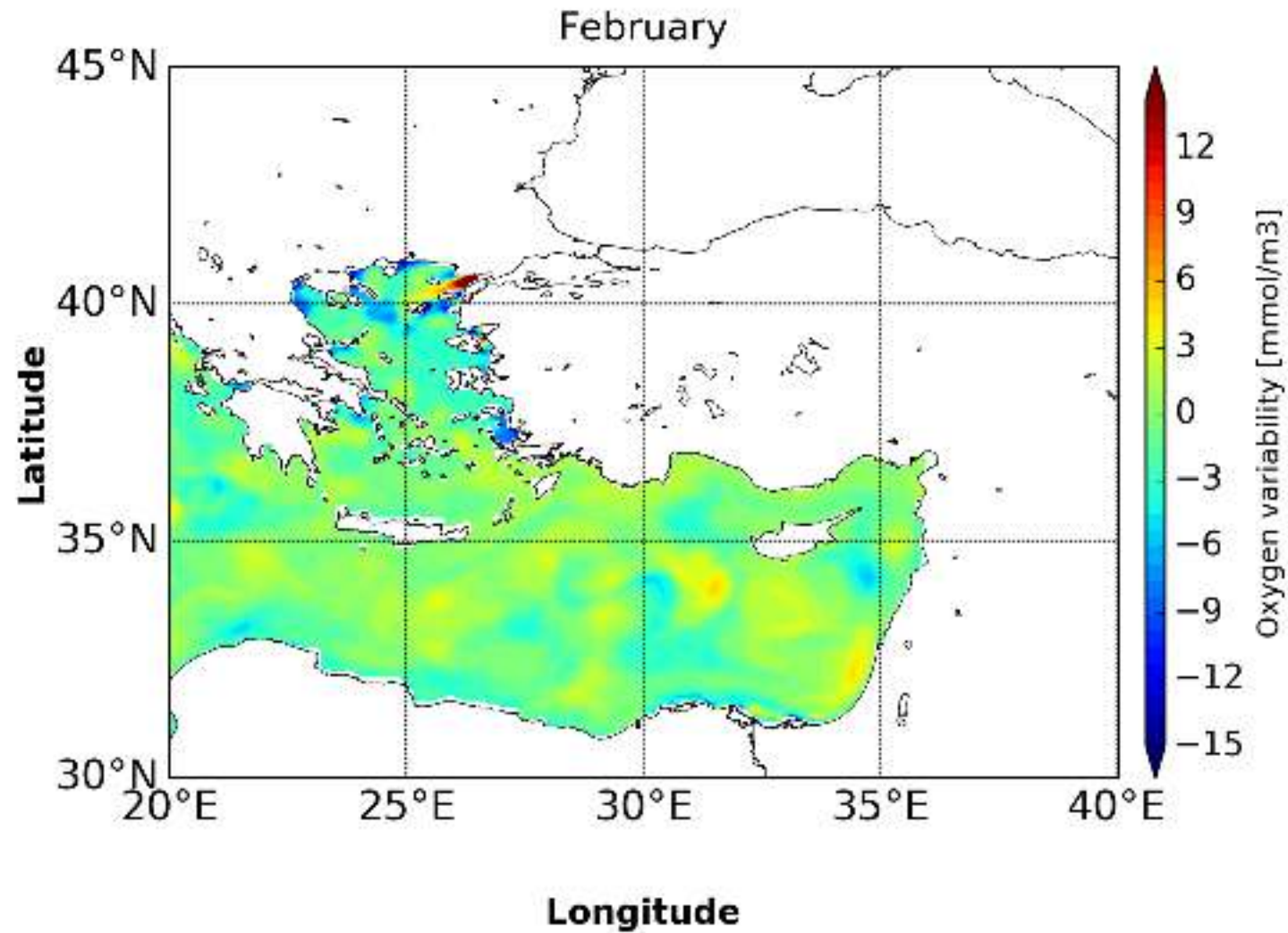
HiSea services

- | | |
|---|---|
|  Early warning service |  Information for planning operations |
|  Real time crisis management |  Knowledge data base |
|  Key performance indicators | |

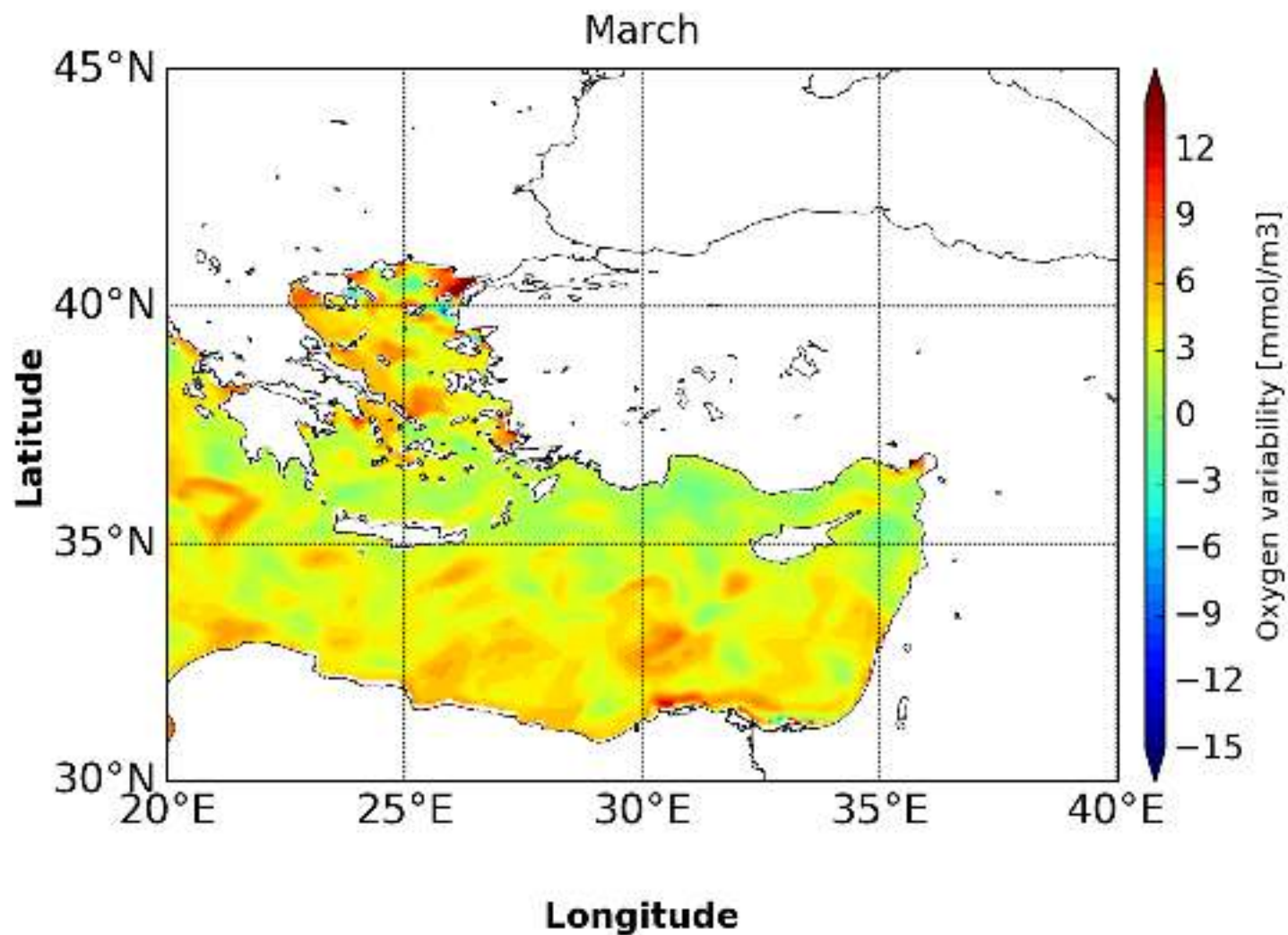
Average monthly
evolution
(source CMEMS)



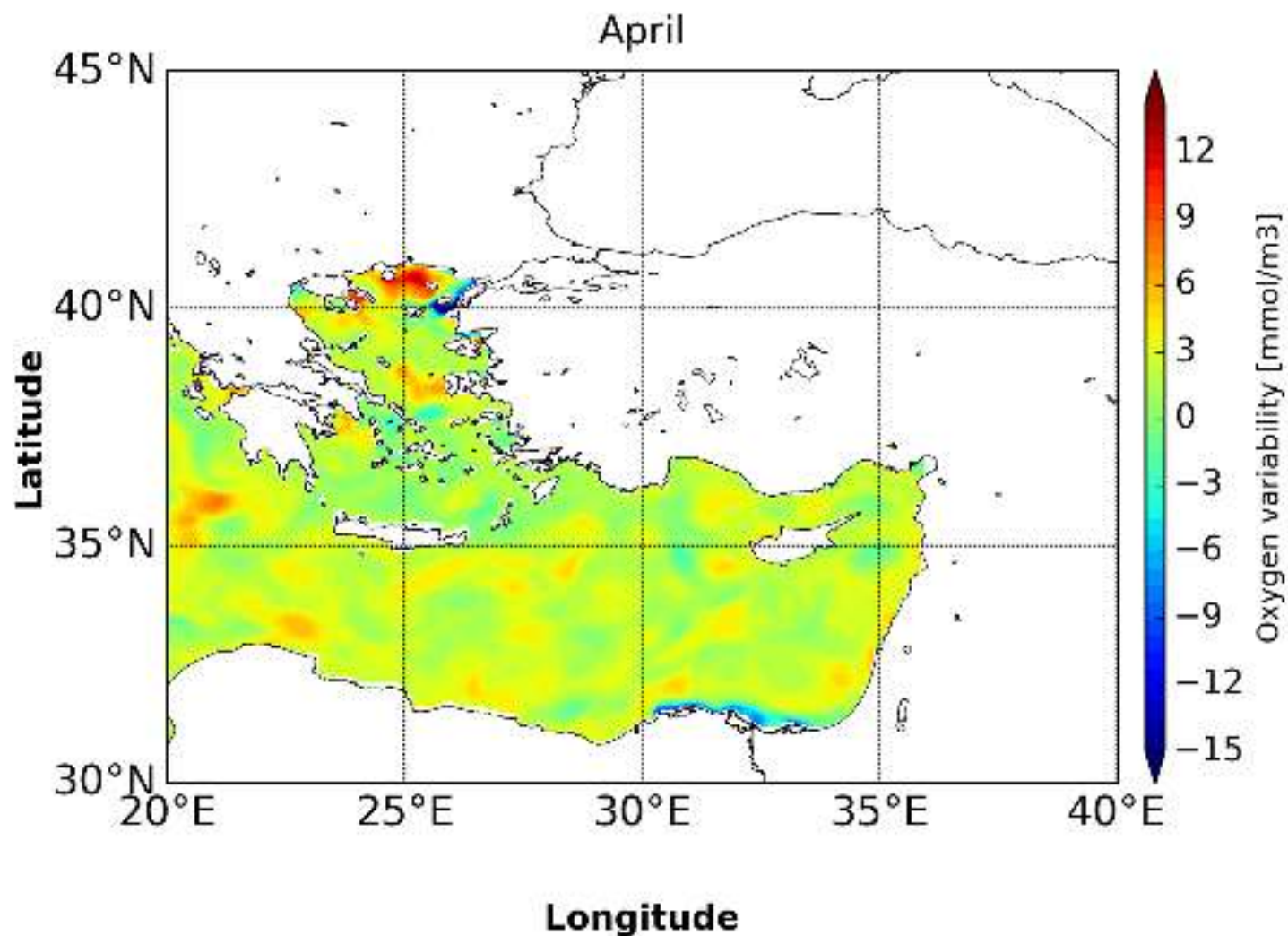
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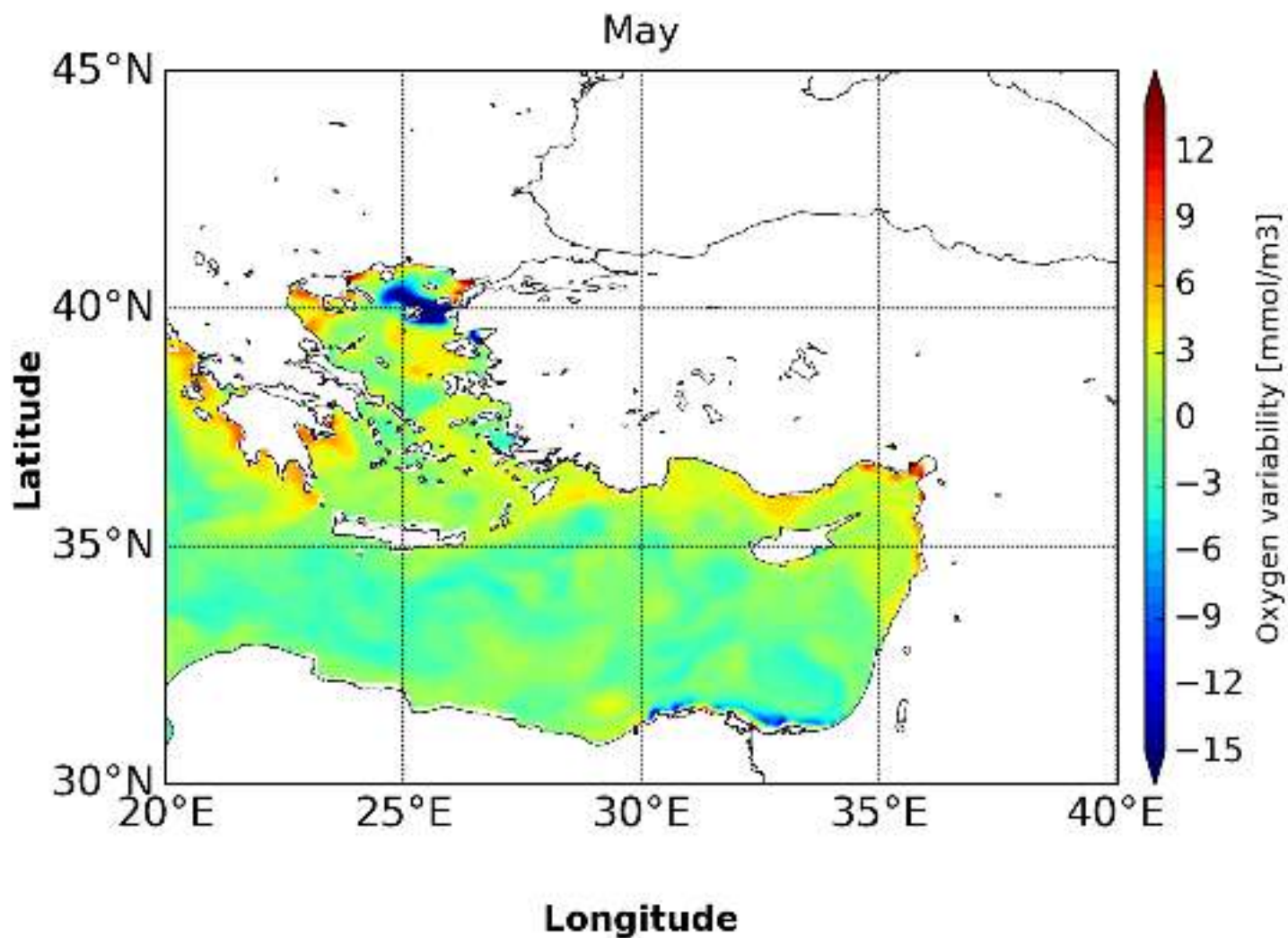
Average monthly
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(source CMEMS)



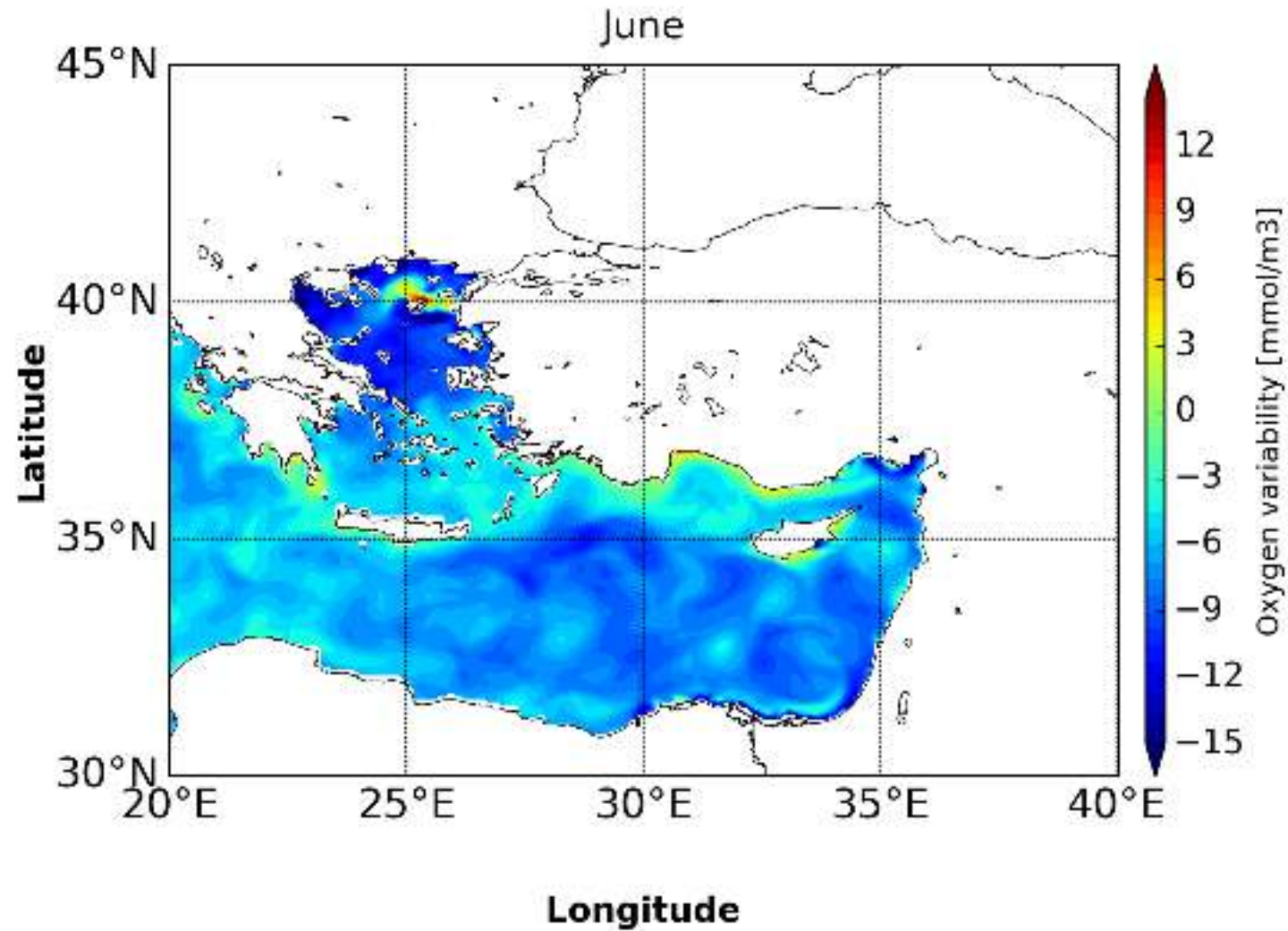
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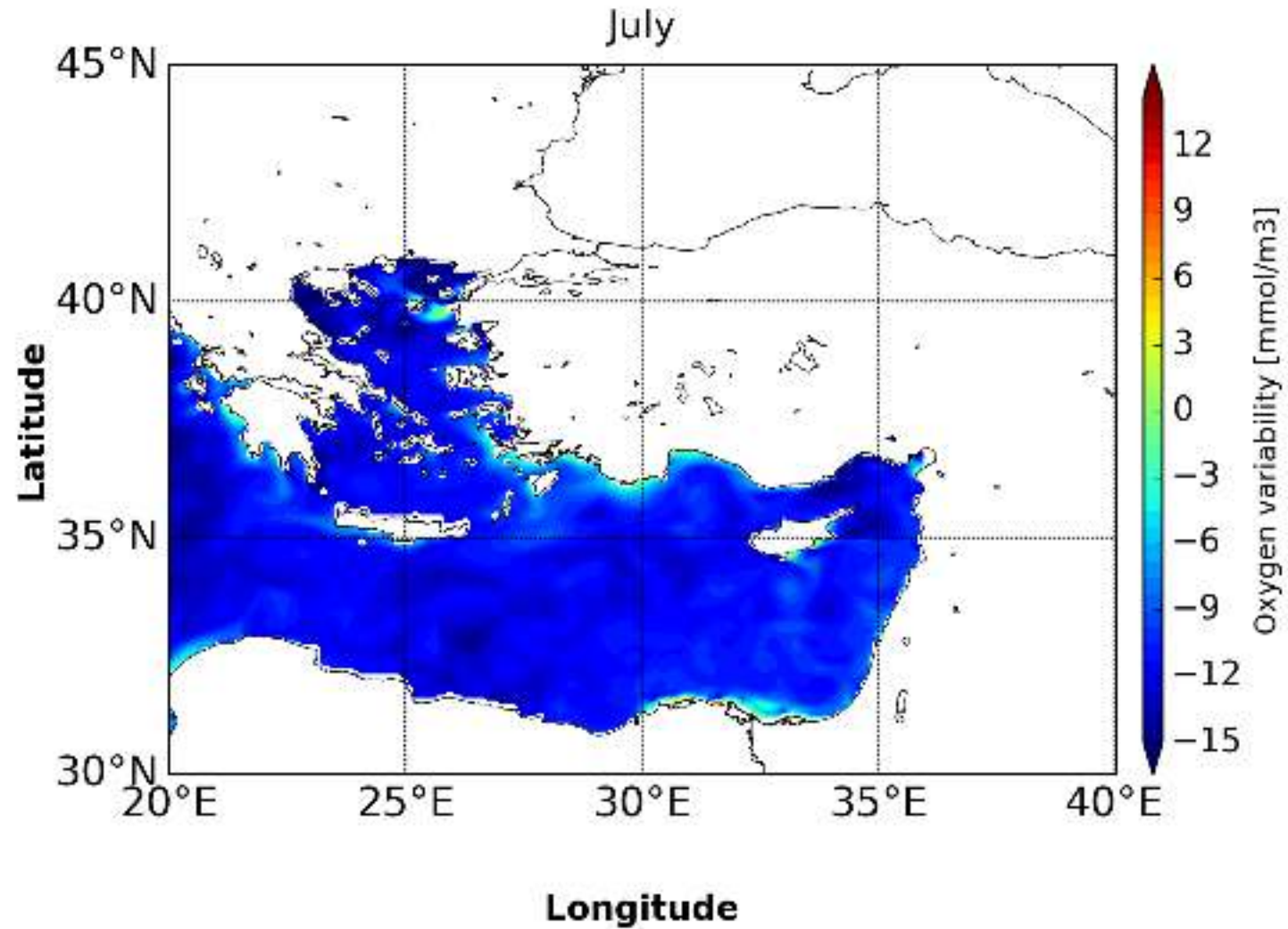
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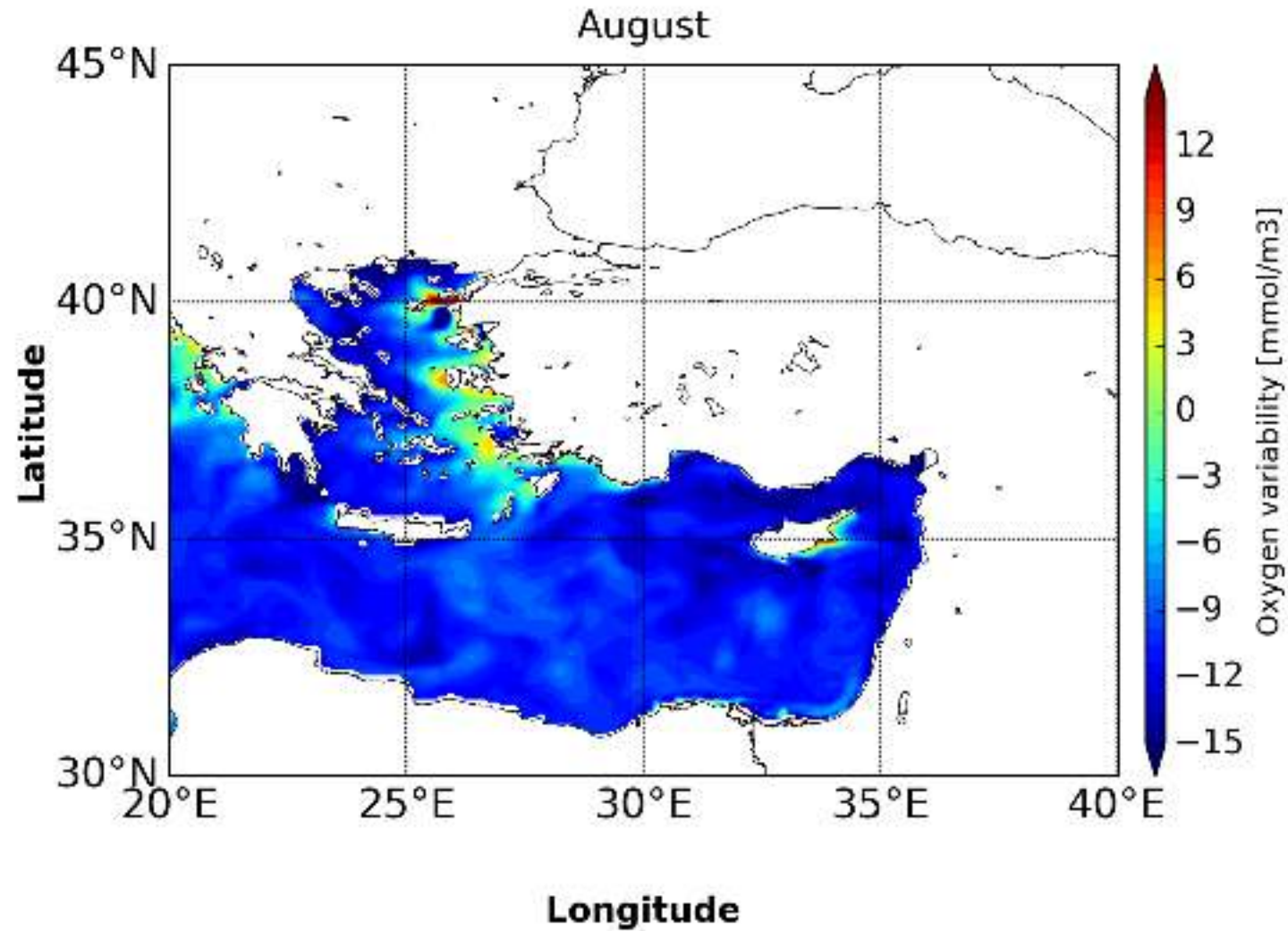
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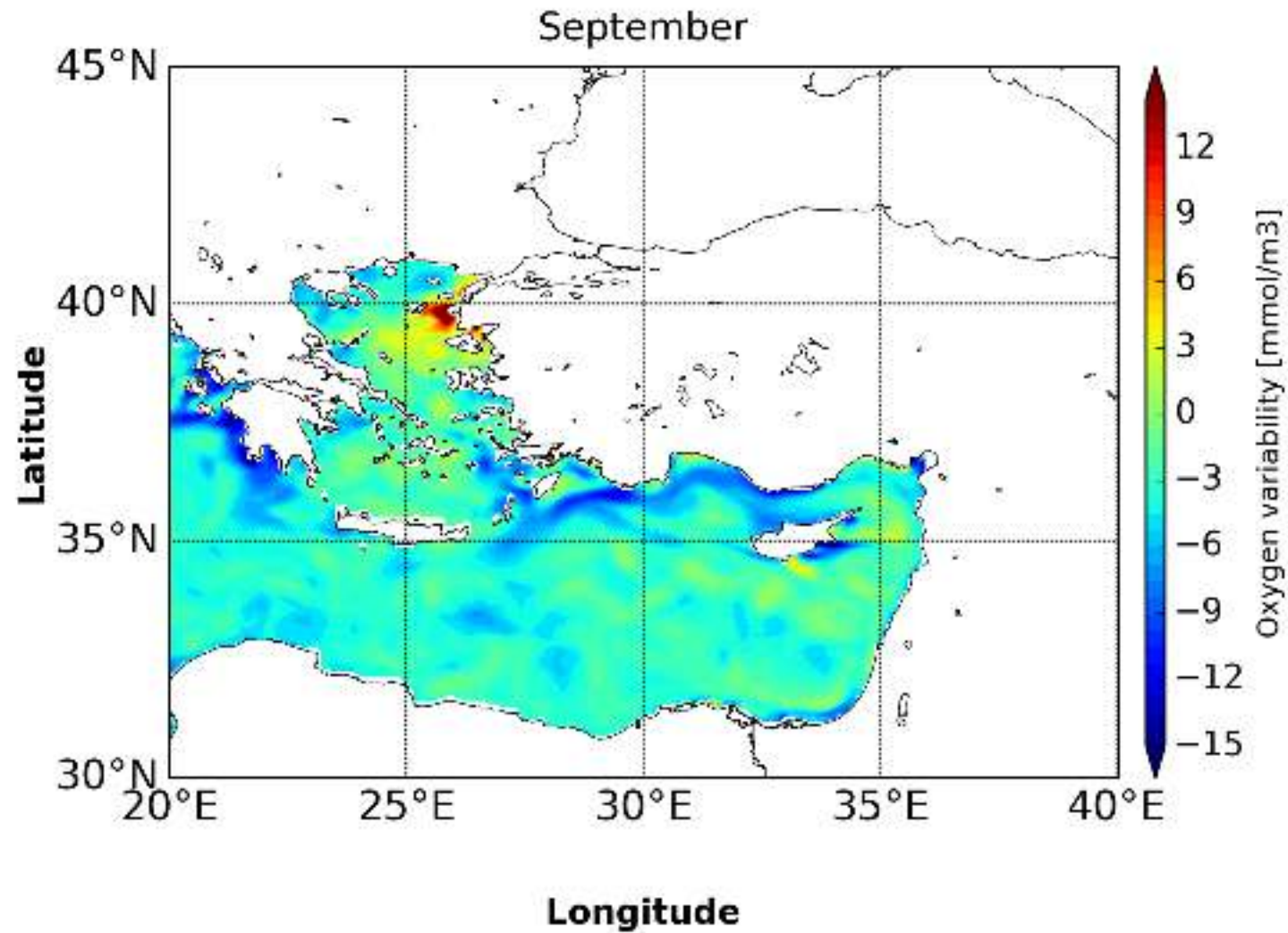
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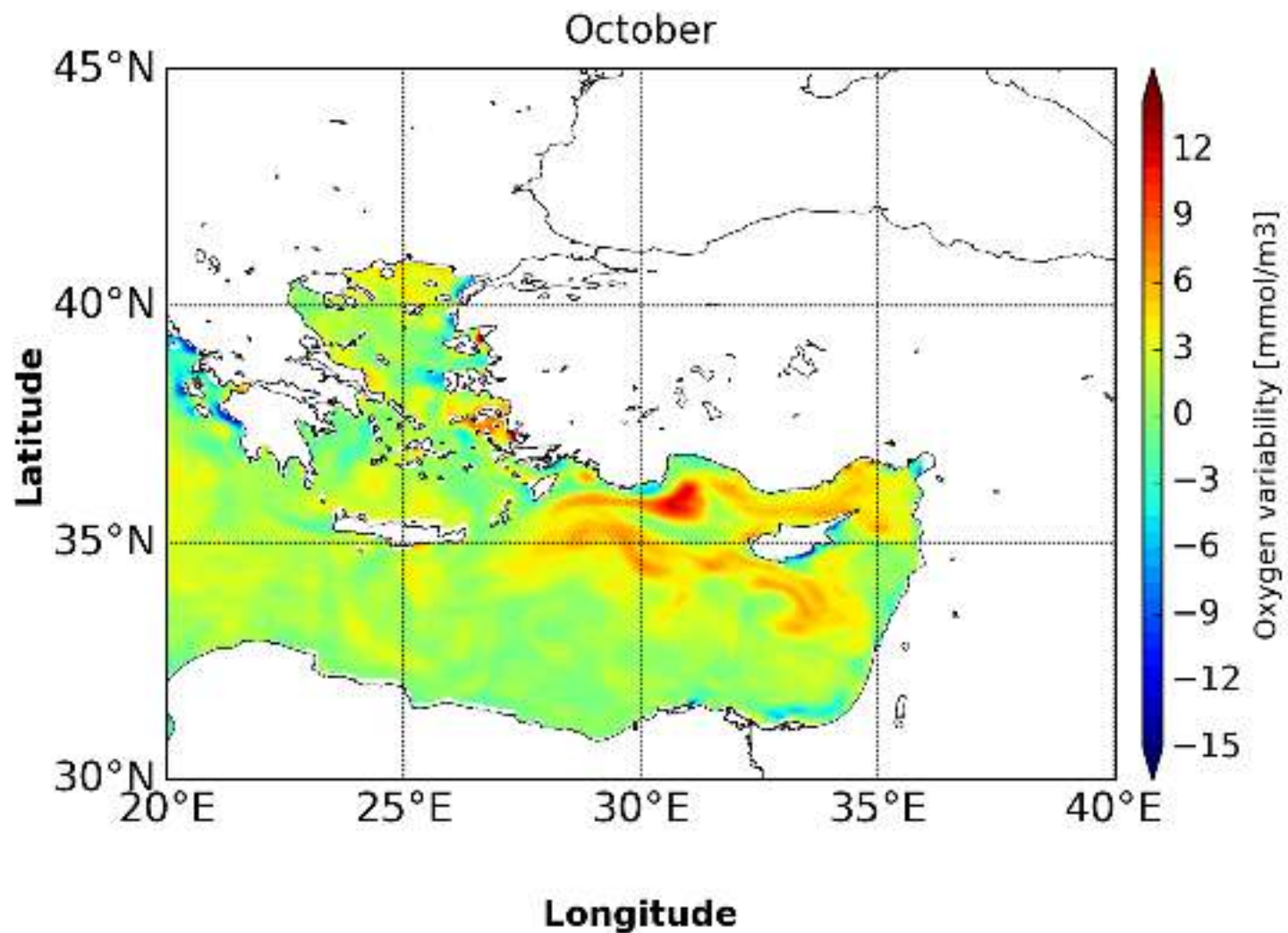
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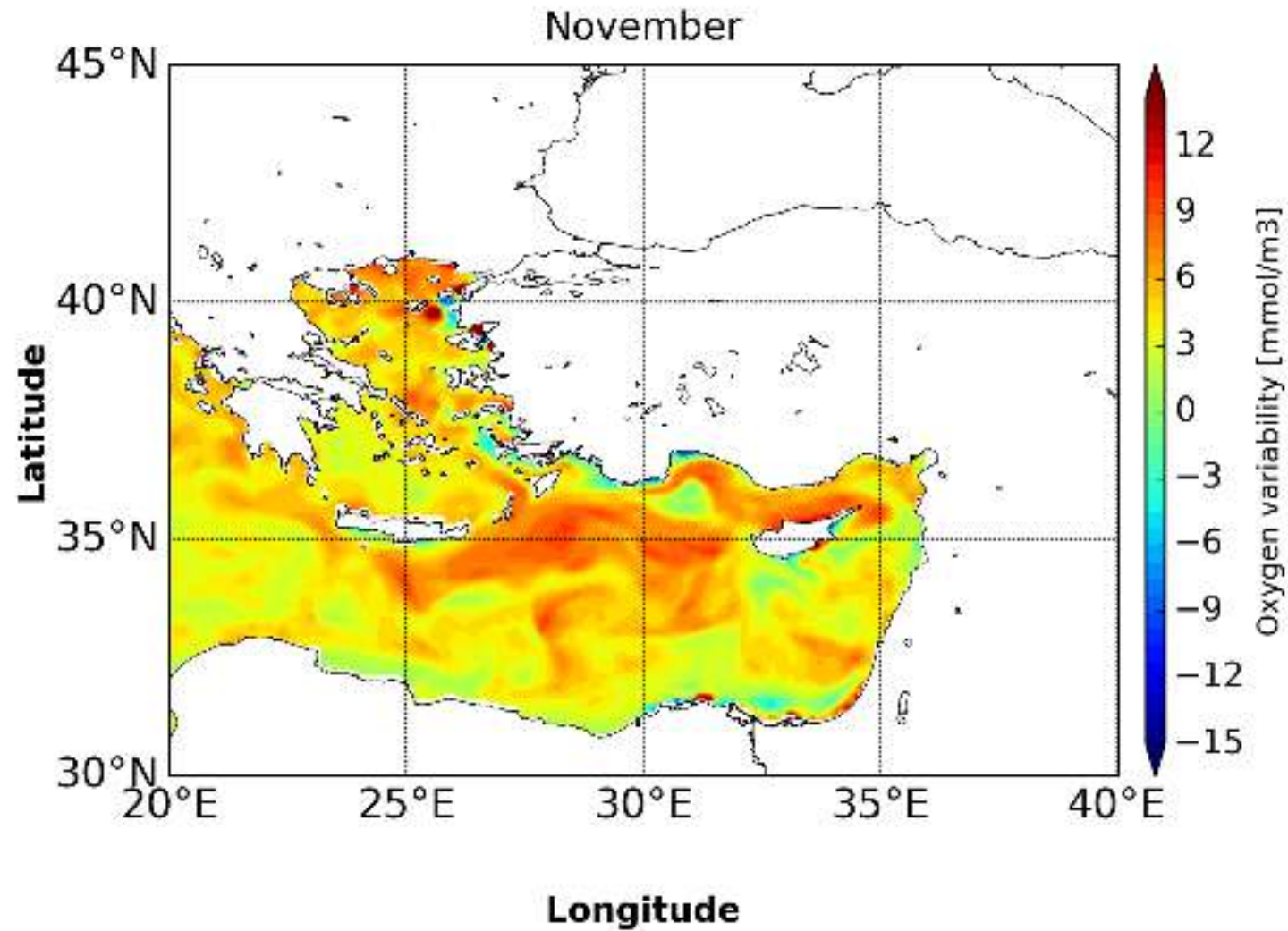
Average monthly
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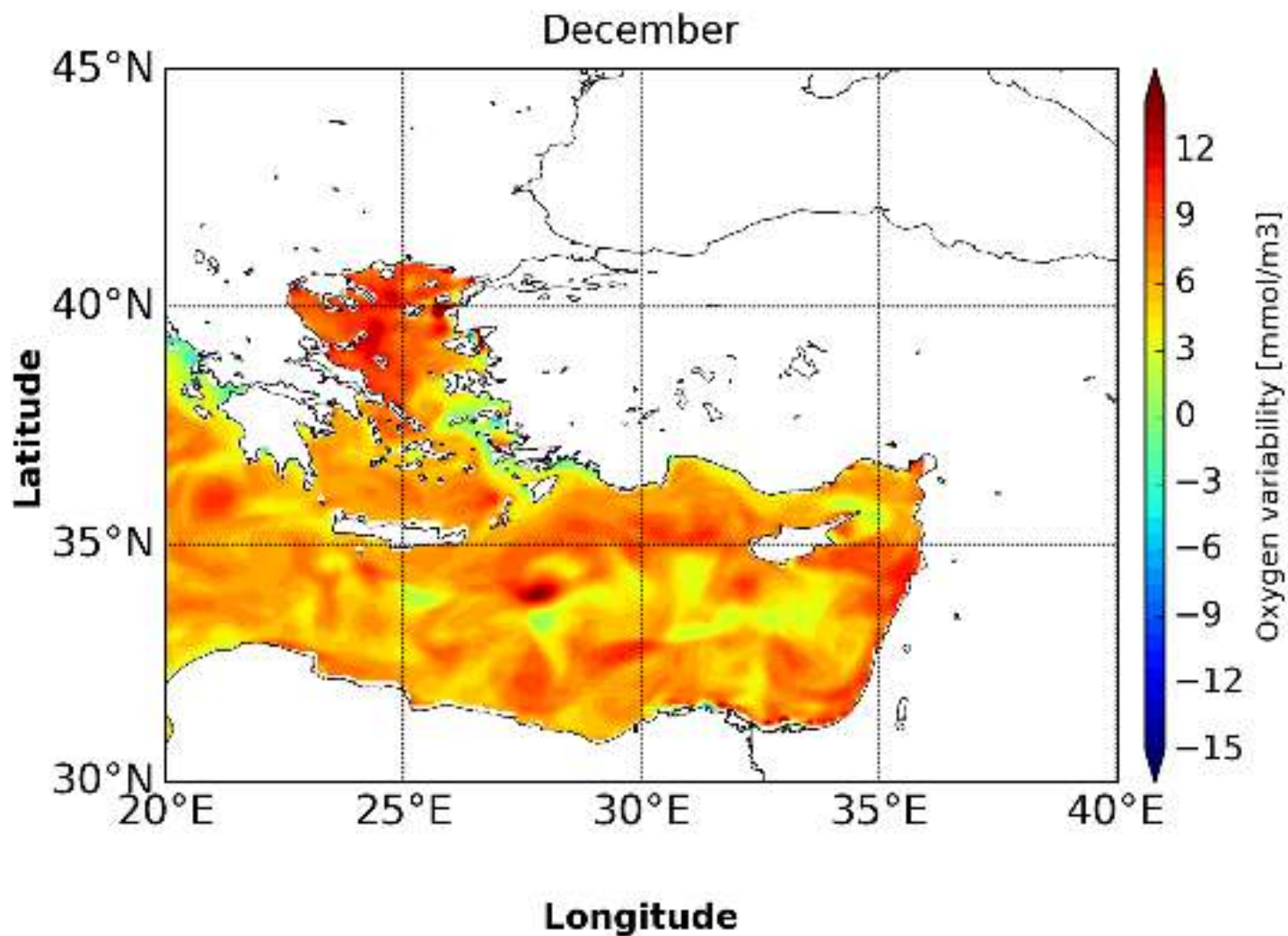
Average monthly
evolution
(source CMEMS)



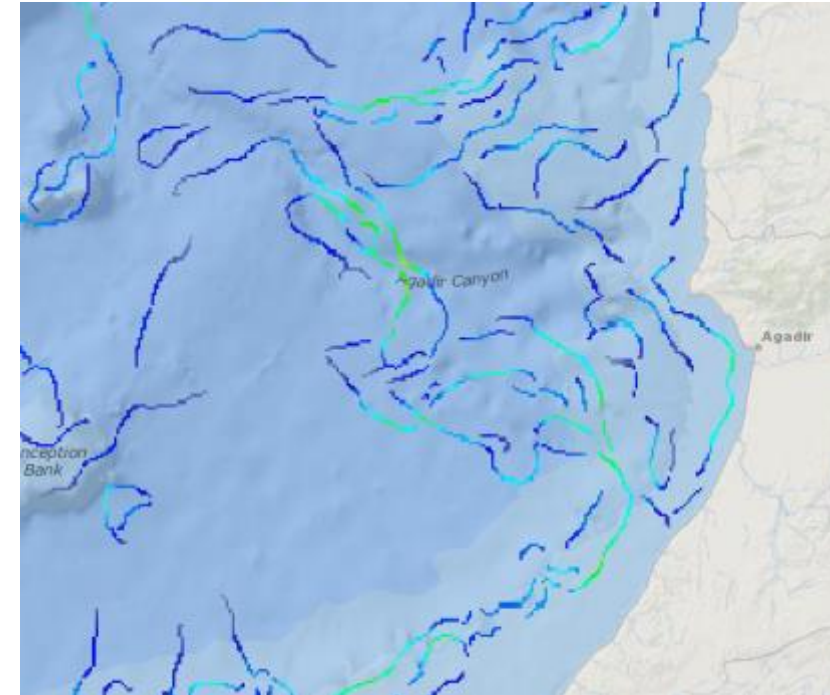
Average monthly
evolution
(source CMEMS)



Average monthly
evolution
(source CMEMS)



- SST fronts occur where colder, nutrient rich water mixes with warmer waters –
- fuelling increased plant growth at the first stage of the ocean food chain
- **Application:**
 - Analysis of fisheries migration routes,
 - assessment of local fishery recruitment,
 - sea surface temperature variability.
- **Availability:**
 - daily, 8-day or monthly basis
 - at a 1 or 2km resolution depending on area.



*SAFI-SST FRONTS (COLOURS
INDICATE FRONT STRENGTH IN °C/KM)
PICTURED: MONTHLY SST FRONTS NEAR
AGADIR, MOROCCO, SEPTEMBER 2015*